ATOMIC STERILIZATION OF FOOD

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The advent of the Atomic Era has opened a vast new horizon to the food industry--the preservation of food by radiation--which appears to hold enormous potential in providing logistical support to the Armed Forces and in alleviating the problem of the comparatively low acceptability of canned foods. To take advantage of this encouraging lead, an accelerated program to study all aspects of the radiation sterilization of foods has been assigned by the Office of The Quartermaster General to the Quartermaster Food and Container Institute for the Armed Forces under the supervision of Colonel John D. Peterman, Commandant.

In addition to increasing the quality of preserved foods, the successful development of a process for the sterilization of foods by ionizing radiations will provide great savings in many areas of our current supply program. This is readily apparent when one realizes that such a method of food preservation would enable the packaging of rations in containers which are more economical, lighter in weight, more conservative in use of strategic materials, less space-consuming, and capable of storage with considerably less refrigeration. All of the above factors are essential attributes in the developmental improvement of the military operational ration. In addition to the logistical economies, this new technique for food preservation will provide for increases in the efficiency of the combat soldier by substantially improving his daily ration and thus stimulating his morale--an ever-important factor in military life.

In keeping with the mission of the Quartermaster Food and Container Institute to perform research and development in food for all three services, the military objectives of the Army have been integrated with those of the Navy and Air Force, and the program has been geared to satisfy the interests and objectives of the respective services in the Radiation Sterilization Program.

The overall objectives and military significance to the Armed Forces can be briefly summarized as follows:

1. Substantial improvement in the acceptability of the B-ration--specifically, canned meats, fruits and vegetables--by eliminating the deleterious effects of the current methods of heat processing.

2. Radical decrease in refrigeration requirements in the procurement, storage, and distribution of fresh components of the A-ration. This takes on a special significance for the field kitchen in combat and for the Navy aboard ship, especially aboard submarines and small craft on extended missions.

3. Elimination of insect infestation--a problem of primary importance in cereals, flour, and components of the ration made from these basic ingredients.

4. Increase in the number and frequency of serving of highly perishable A-ration components which heretofore have been drastically restricted in their operational use.

5. The preservation of special meal-type assemblies for in-flight feeding, box lunches, or even complete meals which could be packaged, irradiated and held without refrigeration for use in special military operations.

Although the execution of the project will be tied firmly to its relevance to Armed Forces requirements, the Department of Army has indicated a keen desire to promote early acceptance of a suitable technology of radiation sterilization by the food processing industry. Thus, another phase of the program will be devoted to the establishment of close liaison and mutual cooperation with the food and allied industries, with the objective of stimulating interest and technical know-how which will be required for the eventual adaptation of ionizing radiations to full-scale plant operations.

The concept of using ionizing radiations to destroy bacteria and other microorganisms is by no means a new idea. Only a short time after the discovery of radium and X-rays, just prior to the turn of the 20th century, scientists had explored this exciting possibility. The intense interest in its commercial application for food sterilization, however, was not really moved into high gear until the cessation of hostilities following World War II. The primary impetus was provided by the development of particle accelerators capable of producing large quantities of high-energy radiations, and the availability of radioactive isotopes and fissionable materials as by-products from nuclear reactors.

Since all food items contain bacteria and other microorganisms which multiply in food and eventually result in decomposition and spoilage, present day processing lays great emphasis on the destruction of these undesirable inhabitants. The application of intense amounts of heat, as in canning, or extreme cold, as employed in freezing, are the principal methods of control now in use. In neither of these methods, however, are all the microorganisms destroyed; and even though the survivors are few, they multiply and eventually cause swellers, springers, or leakers in canned goods, or the decay of foods held under refrigeration.

The revolutionary process of radiation sterilization employs nuclear energy instead of heat to destroy the microorganisms which promote food decomposition and spoilage. Although the ultimate destructive effect of atomic rays is still not clearly defined, it is currently believed that the nuclear rays strike the microorganisms much in the same manner as would a fast-moving projectile fired from a gun. These nuclear bullets either kill the bacteria outright or so disrupt the function of the bacteria that they appear to become sterile, thus eventually wiping out the entire population. Whatever the mechanism, if the food is irradiated in an air-tight container to prevent recontamination, the contents will remain fresh and unspoiled for periods of storage far in excess of present capabilities achieved by canning or freezing.

There are at present three basic types of radiation sterilization which have been investigated in food research, namely: 1) X-ray, 2) electron beams, and 3) nuclear fission products. X-ray sterilization has the advantage of deep penetration, but since most of its energy is lost in the formation of heat exposure times are relatively long and power costs are high. It must be admitted that this process is not economically feasible. Sterilization by electron beams (cathode rays) accelerated by man-made machines offers the advantage of very high efficiency without heat

dissipation. Moreover, sterilization periods are in the range of seconds to minutes. The principal disadvantage of cathode-ray treatment is its low penetration ability. The third method is the use of nuclear fission products. These have been restricted in their use for food research, but considerable experience in other uses can be drawn upon. Radioactive isotopes have been widely used as gamma-ray emitters in food research to simulate radioactive rays which would be emitted by fission products produced in nuclear reactors.

By-products of atomic fission and mobile type reactors for food processing are now in the planning stage, and these developments are potential sources of great amounts of energy available as gamma radiation. This type of radiation is potentially more useful, since its greater penetration ability can be used in sterilizing large-size packaged foods such as No. 10 cans and meat carcasses.

Since in this atomic process there is only a minute rise in temperature in the sterilized products during the short exposure time, on the order of seconds or minutes, this method of processing is often referred to as "cold sterilization." This is in sharp contrast to the present methods of food sterilization, in which the product is processed at a temperature of 240°F. for an hour or more.

Limited research has been carried out by the Quartermaster Food and Container Institute as well as by the Navy, the Atomic Energy Commission, the Department of Agriculture and numerous academic and industrial laboratories. Although development is still in its infancy, research to date indicates that sterility can be attained, and that the process has potential for commercial adaptation. In endorsing this project, the National Research Council has stated that "no other method of preservation of foods is so far advanced, appears to offer as great possibilities, and is as economically feasible as is the radiological sterilization in its present stage of development." It should be emphasized, however, that there are many technical and economic problems yet to be overcome before atomic preservation of foods can become a reality. It is not expected however that the problems will prove insurmountable.

In view of the drastic effect of ionizing radiations on microorganisms, it is only reasonable to anticipate that subtle changes would also take place in the food molecules themselves, and unfortunately the radiation dose required to destroy all microorganisms also produces substantial objectionable alterations in flavor, odor, color and texture. Obviously until foods can be made fully acceptable the advantage of cold sterilization cannot be fully realized.

The effect of radiation on food quality varies among the specific items which have been investigated. For example, milk and dairy products are very sensitive to radiation; bread and cereal products are relatively insensitive; meat and fish products appear to be only moderately affected. It is of interest to note that to destroy most of the organisms present in a given food requires considerably less radiation than is required for 100% sterility. For example, milk pasteurization can be accomplished with approximately 1/100th of the dose required for complete sterilization. It must be candidly admitted, however, that flavor damage is still a problem in milk.

A number of innovations have been studied in an attempt to eliminate or minimize these and other flavor changes. Included are such techniques as irra-

diation while in the frozen state, removal of atmospheric oxygen, addition of "free radical" acceptors to intercept irradiation effects, dehydration and combinations of these methods. To date, however, none of these attempts has been entirely successful. Currently, the major problem in the broad application of ionizing radiation to the treatment of foods appears to lie in overcoming the undesirable side reactions and their effects upon the end product. Even though toxicity and nutritional data currently available appear to be most favorable, extensive, long-range investigations are required to ascertain positively the wholesomeness of irradiated foods.

Other problems which must be investigated in due course include: 1) length of time that food can be stored after irradiation, under varying environmental conditions, 2) development of electron accelerators of higher energy for greater penetration, 3) utilization of waste fission materials and other by-products of atomic reactors, 4) development of new packaging materials since the heavy-gauge, rigid metal containers will no longer be required, 5) economic studies to include production-line feasibility and cost analyses.

The coordinated research program currently being conducted at the Quartermaster Food and Container Institute is designed to provide a well-organized attack on the many problems which lie ahead.

It is the hope of the Quartermaster Food and Container Institute that with this coordinated research program, the Armed Forces will assist in the fulfillment of our nation's objective of "conquering the atom" for this important peace-time application to food sterilization. In so doing, they will have provided men on lonely outpost duty the consolation of food fresh in taste and free from hazards of food-borne microorganisms.